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*THE EDUCATIONAL AND INDUSTRIAL VALUE OF SCIENCE.**

ON the occasion of the formal dedication of a building devoted to the teaching of science, it is fitting that something should be said respecting the claims of science to such generous recognition and such ample provision for its cultivation in a young university, established by a Commonwealth itself still 'in its teens.' In the Atlantic States the stagecoach is almost obsolete. It has given way to the railway, and it is an open question whether transportation by steam will not ultimately yield to the agile trolley wheel. So the old-time college, devoted to the ancient languages, mathematics, and a little leaven of moral philosophy, with its slow-going ways, its simple outfit of benches, a teacher's desk and a chapel, has been superseded by the modern university, with its complex organization, its multiplicity of courses and subjects of study, its laboratories and equipment, and its corps of trained, eager, alert instructors, who are not expected to teach a book only, but to add to the sum of human knowledge, and to awaken in kindred spirits at least an enthusiasm for study, a delight in investigation, which has proved the most efficient stimulus to high intellectual attainments. The erection of the Hale Scientific Building indicates that the University of Colorado aims to pursue its way untrammeled by ancient traditions, with the spirit of modern ideas in education, and in touch with the most progressive institutions of learning.

Shall we pause a moment to inquire what has wrought this change in the aims and methods of higher education in the United States? What new conditions make it possible for a young university like that at Chicago to forge toward the front in two or three short years? Universities have always been considered as institutions of slow growth. They represent the accretions of

*Read at Boulder, Col., March 9, 1895.

years and centuries even, if we broaden our view sufficiently to include those of Europe. Such indeed are the customs, the traditions and the general policy of a great university with decades or centuries of history behind it. Every ancient seat of learning has a character peculiarly its own. There is an indescribable charm attaching to crumbling, ivy-cumbered walls; to time-stained libraries, that point with motionless fingers back toward their more silent authors; a subtle influence in the steady gaze of the famous sons of the college, as they look down on the younger generation from the deepening canvas in the memorial portrait hall. Who that has a fibre of his soul tuned to vibrate in unison with melodies of the past can fail to feel an energetic thrill as he stands among the distinguished sons of the Harvard of former years ranged around the walls of 'Memorial Hall,' or as he walks softly through the portrait gallery of Christ Church College in Oxford? These influences are not to be despised. They are an inheritance from the long past and are still potent. Addison still walks under the arching trees by the quiet stream at the back of Magdalen College; Wolsey and Wesley and Gladstone still linger in the noble hall of Christ Church; and Newton's rooms remain near the imposing gateway of Trinity College in Cambridge. I love to step within the charmed circle of such subtle influences, to yield to the magic spell, and to count myself a part of all this glorious past.

But the modern spirit prevades the oldest institutions, and great seats of learning are rising on new foundations. In both old and new the most marked characteristic of the teaching of the present is the scientific method. It has pervaded every department and has proved the leaven that, being taken and hid in the ancient curriculum, as inert as the three measures of meal, has leavened the whole. Till the introduction of serious scientific study with laboratory facilities, the educational methods which had prevailed for centuries were still current. As late as twenty-five years ago in a respectable New England college it was not possible for a student to learn his science by means of laboratory study. All this has now changed, and no less important a change has taken place in the teaching of language and literature. It is significant that this advance in pedagogical practice, the introduction of the method by investigation as compared with mere memoriter acquisition, has been coincident with the introduction of the serious study of science into our American colleges and universities. Twenty-five years ago the Massachusetts Institute of Technology led the way by introducing the physical laboratory into the study of physics. Some progress had already been made in the teaching of chemistry by direct contact with chemical reactions at the work table. It is only fifty years since Liebig inaugurated the system of studying chemistry by the laboratory method, and it is highly probable that the physical laboratory established by William B. Rogers in Boston marked the introduction into the regular curriculum of instruction in physics by experiment.* I venture to say that no greater success has followed any new departure in education. The physical laboratory is now a necessary part of every institution devoted to higher learning; its growth has been phenomenal. Enormous sums of money have been expended for physical laboratories and their equipment. The example set by this oldest branch of science has had a most beneficent influence in several directions. It has improved the quality of the work in the secondary schools. The physical laboratory is now a necessary part of every first-class high school equipment. It has also stimulated and advanced original work. Every

* Professor Mendenhall in *The Quarterly Calendar* of the University of Chicago, August, 1894.

instructor competent to fill a professor's chair in physics is now expected to add something to the stock of knowledge by his independent investigations. It has thus made graduate instruction possible in American universities, a movement having the most hopeful outlook and of the most profound educational import.

A third and most complete leavening influence is that the method by experiment and original investigation adopted by science has compelled other departments of learning to become its imitators, so that now the laboratory method prevails in nearly every department of learning. This result is too patent to be questioned even. Psychology, language and history have yielded to the powerful example set by physics and chemistry. Archæology has its work-room, its laboratory; language its photographs, its projections, its casts and reproduction of ancient life and times; while psychology has appropriated not only the methods, but the apparatus of the physicist.

Now a movement which has been such a powerful operator in solving the problem of education in every branch of learning has a significant value in the intellectual training of American youth. In fact, the value of science in any system of liberal education is so generally admitted that it is an almost needless expenditure of energy to enter into a discussion relative to its merits. It is no new comer for whom room is benevolently or patronizingly made in order that it may display its powers and demonstrate its worth. It acknowledges other claimants as peers, but admits no superiors. It came long ago to stay.

I should like to point out two or three aspects of the study and pursuit of science not often alluded to or recognized, but on which I lay much stress. The first relates to the cultivation and chastening of the faculty of imagination. Sir Benjamin Brodie said in a presidential address to the Royal Society many years ago: "Physical investigation, more than anything besides, helps to teach us the actual value and right use of the imagination—of that wondrous faculty which, left to ramble uncontrolled, leads us astray into a wilderness of perplexities and errors, a land of mists and shadows; but which, properly controlled by experience and reflection, becomes the noblest attribute of man, the source of poetic genius, the instrument of discovery in science, without the aid of which Newton would never have invented fluxions, nor Davy have decomposed the earths and alkalies, nor would Columbus have found another continent." It would be a grievous mistake to suppose that the cultivation of science contributes only to accuracy and exactness; to the development of the habit and power of observation, and to the education of the reasoning faculty as applied to the concrete—to the objects and phenomena of nature. All of these constitute a valuable training and are demonstrable results of an honest effort to understand and coördinate the phenomena of nature. But as soon as the student of science passes beyond the mere elements he must train himself to the habit of conceiving things which "eye hath not seen, nor ear heard, nor have entered into the heart of man." He must emancipate himself as much as possible from the domination of his sensations, and must learn that sense-perceptions should not be projected into the outer world of nature, but that they are only symbols of objective phenomena presented to consciousness, which the imagination, aided by reason and reflection, must interpret. Not only is the imagination called into activity by the common occurrences of the natural world lying along the level and the horizon of man's experience, but it is powerfully stimulated by the more remote phenomena above him and below him. Man contemplates the starry firmament on high, the spangled heavens,

flecked with barely discernible patches of light; he puts together these trembling nebulæ, as the dismembered parts of a puzzle panorama of the heavens; and out of them all, triumphant over time and space, he constructs a nebular theory of the visible universe. He thus concludes that the various bodies of the solar system "once formed parts of the same undislocated mass; that matter in a nebulous form preceded matter in a dense form; that as the ages rolled away, heat was wasted, condensation followed, planets were detached, and that finally the chief portion of the fiery cloud reached, by self-compression, the magnitude and density of our sun" (Tyndall).

On the one hand, the telescope and spectroscope are aids to the imagination in penetrating the almost inscrutable mystery of the skies; on the other, the microscope enables it to descend somewhat into the no less limitless underworld, and to sink the exploring plummet to depths as far removed from the field of the microscope as the celestial boundaries are beyond the vision attained by the telescope.

How wonderful, also, is the ethereal medium which man's imagination has constructed, the vehicle of the energy wafted to us from sun and stars! To the mental vision this medium fills all space and quivers with radiant energy—that winged Mercury, bearing messages to man from all the worlds on high. Even electrical and magnetic phenomena are utterly inexplicable without it. The imagination of Faraday, of Maxwell, and of Hertz, has woven out of it a texture of lines of electric and magnetic force, which are as real to the electrician as the machines and conductors which he mantles with them. Every conductor conveying a current, every permanent or electromagnet, is surrounded with its system of lines of force in the ether. And when an alternating current traverses a conductor these lines of magnetic force are propagated outward from it in waves which spread with the velocity of light. In fact, they are identical with light objectively, except in point of wave-length. Thus the theory, imagined by Maxwell with the insight of marvelous genius, and confirmed later by the classical experiments of the lamented Hertz, is now accepted doctrine by physicists the world over. The existence of the ether is now seen to be a necessary consequence of Roemer's discovery in 1676 of the finite speed of light. For the transmission of light is the transmission of energy; and a medium of transmission is a necessary postulate as the repository of this energy during the time of transmission. Newton imagined the light-giving body projecting minute particles, or corpuscles, through space and carrying their energy with them as a bullet carries its energy to the mark. These entering the eye excite vision by impact upon the retina. But Newton's corpuscular theory failed because of its final complexity and the crucial test applied to it by the great experimenter, Foucault.

The undulatory theory, on the other hand, requires a continuous medium, and the energy is handed along from particle to particle as an undulation. In this way energy is conveyed by sound and by water-waves across the surface of the sea. According to this theory, a luminous body is the center or source of a disturbance in the ether which is propagated in waves through space. They are electromagnetic in origin, travel with the velocity of light, and entering the eye excite the sense of vision. Thus far have we been helped along by the imagination of genius and the contributory aid of experiment. Mean and unfruitful indeed is the science which has not been enriched, extended and vivified by the scientific imagination. Where dull reason halts and the understanding is confounded by appalling obstacles, imagination overleaps them all and the barriers are dissolved

away. The boundaries of scientific inquiry have thus been moved forward and new territory has been added to the cultivated domain.

Again, let me direct your attention to another feature attending the prosecution of scientific research. While it is undoubtedly destructive of credulity, and is perhaps but a weak ally of faith, it is nevertheless a powerful promoter of honesty. The object which the scientific investigator sets before him is to ascertain the truth. He is devoted to it and pursues it with unremitting toil. But this is not all. He not only seeks truth, but he must be true himself. It is difficult to conceive of any circumstances which would induce him to play a dishonest part in scientific research. He has every inducement not only to accuracy but to honesty. He may unwittingly blunder and fall into error, but if he is untrue he is certain to be exposed. No discovery is permitted to go unverified. It must undergo the searching examination of scientific inquiry. The investigator must submit his data and must seek to have his results confirmed. There is, therefore, every inducement for him to be absolutely truthful. This condition imposes upon him also the habit of conservatism and moderation in statement. He is not expected to plead a cause or to make the most of the occasion for himself. In this regard his position is in contrast with those whose profession makes them the allies of faith, but whose moderation is not always known to all men; for their assertions are not brought to the touchstone of revision and justification, and the released word flies over the unguarded wall. The habit of the scientific investigator is to subject every question to the scrutiny of reason and to weigh probabilities. He obeys the injunction, "Prove all things; hold fast that which is good." He respects conscience, but has no use for credulity. He exhibits devotion to principle, but dogmatism, whether in science or religion, has no place in his creed. He looks not only upon the things which are seen, but also upon the things which are unseen. You may suffer me to remind you that the most noted American atheist is not a man of science, while one of the forceful books of modern times, 'The Unseen Universe,' which aims to lay a foundation for belief in a future life without the aid of inspiration, was written by two distinguished physicists. Science examines the foundations of belief. It takes nothing from mere tradition, on authority, nor because it is an inheritance from the past. It admits its own limitations and the somewhat circumscribed boundaries set to the field of its inquiries; but within this province it seeks to ascertain only the truth. It recognizes not only the promise and potency of matter, but the power which makes for righteousness.

Turning now to some more practical matters, it is strongly urged that the study of science should begin early, before the taste for such study has become atrophied by too excessive attention to language and mathematics. It is a fact established by observation that if a student gets his first introduction to science only after he is well along in his college course he comes to it with a mental inaptitude that often produces discouragement and precludes the possibility of much satisfaction in its pursuit. The procedure in scientific study, especially when it includes the method of the laboratory, is so radically different from that involved in the study of language that one trained only in the latter finds himself in a foreign field when he enters the former. The study of language, considered merely as the symbolism of thought, or the instrument for its expression, is most valuable and essential. You shall hear no word from me designed to depreciate the value of linguistic study and training. It is rather

to be deprecated that scientific men do not generally pay more attention to the formation of a correct English style, and do not oftener acquire the ability to express the results of their studies in more elegant English diction. On the other hand, an exclusive training in the so-called humanities leaves the student unsymmetrically developed. The elementary study of language is largely a study of the forms and symbols of speech; to the young student, at least, the thought is altogether a secondary consideration. Mathematics furnishes a training in the relations of abstract number, and in the manipulation of symbols invented to facilitate operations expressing the relations between related quantities. It is not only a valuable agency in mental development, but it is a powerful instrument for the investigation of phenomena in those branches of science to which applied mathematics is indispensable. Science has more to do than either language or mathematics with objective phenomena. The student of science soon finds that he has a new set of relationships with which to deal. He may be familiar with mathematical theorems and solutions, but his first difficulty is to see the points of attachment of mathematics to the facts of physical science. He is armed with a weapon of most modern design and exquisite workmanship, and he has possibly obtained some skill in target practice, but he has no eye for game. He may be too short-sighted to see that there is any game even.

Skill in the use of scientific methods of reasoning and acquirement comes only after the mind has been kept for some time in contact with science, so that it has acquired the scientific spirit and aptitude. The preparation for the scientific work of the university should therefore begin in the secondary schools. Continuity in scientific acquisition is as essential as in that of language or mathematics. While six, or even eight, years are given to language in the high school, counting the four years with three studies each as twelve, it is thought by some to be an evidence of great magnanimity if two years out of the twelve are given over to the mere elements of physical and biological science. It is obvious to any careful observer that much improvement has been made in the teaching of science in secondary schools within the last few years. More competent teachers are employed, laboratory facilities have been provided, better manuals have been written, and the tone of the science department has been improved by the fact that preparation in science at last leads to something further in the university. This continuity in the pursuit of scientific studies has already furnished qualified teachers for the lower schools. What wonder if the teaching of science in the schools should not have proved as fruitful as was once hoped! Till recently language and mathematics have had the training of the teachers throughout our whole educational history, and if science secured entrance to a secondary school at all it got there in a secondary place. All that science asks is to be placed on equal footing with other lines of study. It demands no preferences and is strenuous that no ultimate bounties shall be extended to other branches. There should be no favored nations in the world of education. It recognizes no excellences in language or literature to justify superior awards at graduation. There are no sacred vessels in education which science may not touch, no shibboleth which she cannot pronounce, no holy of holies which she should be forbidden to enter. The ideal culture course is not all science, not all language, and not all mathematics, but a judicious combination of these and other branches. It would be no less logical for one to make one's course chiefly science than to make it chiefly language; but when the student has

successfully completed his course, making due allowance for personal differences and needs, no reason seems to me valid for not crowning the equivalent work of all with the same degree.

Reference to the other aspect of my subject has, perhaps, been too long delayed. Science has not only educational value of a high order, but industrial applications as well. Discovery and scientific training precede invention. The quality of mind that discovers the laws of nature is of a higher order than that which makes application of them. The genius of Faraday and Henry, who discovered the laws of magnetic induction, must not be dimmed or diminished by reduction to the level of even the greatest living inventors. The contributions of these men to the well-being, comfort and happiness of mankind cannot be over-estimated. They laid the foundation in magnificent discoveries of those splendid applications which have dazzled the world in recent years. So thoroughly intrenched in theory and practice are Faraday's conceptions at the present day that they enter into every design of motor or dynamo. They have been shot through the entire body of practice and are intertwined with every thread of electrical thought.

On the other hand, one must not fail to note that the wonderful applications of science have reacted in a favorable way upon theory and investigation. They have proved an effective stimulus to research and have furnished a multitude of problems for original investigation. Scientific discovery and inventions involving scientific laws are two handmaids of national improvement. They are larger agencies for the advance of modern civilization than any others. Astronomy has made splendid contributions to navigation since Galileo suffered for teaching that the earth revolves daily on its axis and yearly round the sun. It has also made possible modern chronometry by giving us the accurate unit of time. The contributions of modern chemistry are so numerous and so important that it is difficult to particularize. It has taken a useless refuse of the gas retort and converted it into resplendent dyes that rival the gorgeous colors of the rainbow. It has improved and cheapened the processes of manufacturing iron till the cost of the ore and the fuel control the price of the product; and old establishments, far removed from the cheap supply of either, have had to succumb to the march of events.

Bacteriology, the ally of chemistry, working largely by chemical methods, gives the fairest promise of discovering the cause and the prevention of disease. Its beneficent aim now is to devise methods of securing immunity from the most deadly diseases, whose ravages are greater than those of great civil wars. Important discoveries in this direction are impending, and medicine is fast becoming a science instead of a body of empirical rules.

Bacteriology has already isolated and identified a large number of pathogenic or disease-producing germs and hopes in time to corral them. It has demonstrated that disease is not due simply to the presence of the bacillus, but to the specific poison resulting from its growth. It has added consumption and pneumonia to the list of infectious diseases; and the discovery of the cause is a long stride toward the goal of prevention.

The specific direction in which the large body of scientific discovery is turned to practical account is in the several branches of engineering. The civil, mechanical, electrical and mining engineers are the prophets of the new civilization. They have pierced the highest mountains; hung highways over the most dizzy cañons; constructed a rushing steed that feeds on the compressed vegetation of the carboniferous age and wearies not; they have brought the nations

together so that the great oceans scarcely separate them; they have bound continents together by wonderful cables embedded in slimy ooze at the bottom of the sea. Eiffel reared his tower a thousand feet to pierce the sky; Baker projected three of his out 1700 feet horizontally without staging to bridge the Firth of Forth; and over them fly four hundred trains daily without slackening speed; each span is longer than the Brooklyn bridge, and there are three spans. The seven wonders of the world have become seventy, and still the modern engineer pauses not. He now soberly contemplates a deep waterway from the great Northwest to the Atlantic coast. He has not even abandoned the problem of aerial navigation, but attacks it on a new principle. Archimedes is said to have declared that if he had a place for a fulcrum he could move the world. Professor Vernon Boys has just weighed the earth and determined its density to the third decimal place by means of two gilded balls suspended by a fiber of quartz, finer and stronger than a spider's web. Not content that the earth yields her yearly increase, and that the sea furnishes abundant food, the engineer burrows into the eternal hills and seeks for hid treasures in the depths of the earth. The gold and the silver he wishes to be his also. He even establishes an electric plant some 1600 feet underground, converts the power of the descending stream of water into electric energy, and sends it back to the surface for further service.

He has contemplated the colossal cataract at Niagara not only as a display of natural grandeur, but as an example of unlimited power running to waste. At last he is nearly ready to recover a small part of this power and to transmit it to distant cities, where it may turn the wheels of industry or be transmuted into light. No grander problems remain for solution than those even now confronting the electrical engineer. The swiftness with which he has already passed from one almost insurmountable task to another has amazed no one more than those most familiar with the means employed. If electrical engineering is still in its infancy it is certainly a giant infant. It has long since outgrown its toys. With the nerve and audacity of vigorous young manhood it quails before no obstacles and acknowledges no impossibilities. Having practically banished the plodding horse from the street railway, it is getting ready to enter the lists against the locomotive. If your city is not seated near a source of power it will undertake to bring the power to you. The mountain can not go to the city, but the city can go to the mountain for its power. Electrical engineering stands at the door of the twentieth century, ready to accept the tasks that it imposes, and eager to enter upon a new period of discovery and application.

A marked feature of educational history in the United States for the past twenty-five years is the rapid increase in engineering schools, partly on independent foundations, and partly as a professional department of universities. Of this latter class the only ones existing a quarter of a century ago, so far as I know, were the Lawrence Scientific School at Harvard, the Sheffield Scientific School at Yale, and the courses in Civil Engineering in the Universities of Pennsylvania and Michigan. The first two, as their name implies, were devoted quite as much to the teaching of pure science as to engineering. They attracted but little attention, and in fact the Lawrence School had but a moribund existence for many years after the establishment of the Institute of Technology in Boston. Recently it has had new vigor infused into it and has profited by the growing interest in engineering education. Cornell and the State Universities have led the way in the establishment of engineering schools, and

their example has been followed in a way that demonstrates more completely than anything else could that a popular demand exists for engineering instruction.

Civil engineering came into the University of Michigan in 1853, with the late Dr. Alexander Winchell, as an adjunct of Physics. It had an independent instructor in 1857 in the person of Professor De Volson Wood, who is well known in the profession at the present day. Mining engineering followed in 1875. Mechanical engineering was introduced by a professor detailed from the U. S. Navy Department in 1881. Finally the course in electrical engineering was begun in 1889. The success of this last course has more than justified its introduction, as the roster of students in it already exceeds that of either of the older engineering courses. This growth is attributable to the popular interest in the subject.

The engineering courses are primarily professional as distinguished from the literary curriculum. They lay the foundation in theory and a moderate amount of practice for distinguished careers in a private professional capacity and at the same time in the service of the State. A large portion of the graduates of American technical schools have been very successful in their professional career. The presence of a considerable body of trained engineers, distributed throughout the country, has had a marked influence on the number and character of the public improvements made. If a great commonwealth is justified in maintaining an institution of higher learning because of the public weal, as I fully believe it is, then the maintenance of schools of engineering is approved by considerations of high public interest.

From an educational point of view, the courses in engineering furnish a thorough and by no means narrow intellectual training. The rigid discipline in pure and applied mathematics, the courses in physics and chemistry, the attention given to modern languages, are all additional to the special instruction in engineering studies; and while they serve as a foundation for them their value as a means of intellectual culture are just as great as if they were pursued for this purpose alone. An eminent scholar, Professor Ritter of Germany, has recently testified to the success of technical education in the United States and says that the Americans have outdone Europeans in this regard. The theoretical side of the technical branches Professor Ritter believes to be less solid here than in Germany; but against this defect he sets the "truly grand achievements in engineering and machine construction in the United States." In the normal growth of our engineering courses they will gradually be strengthened on the theoretical side. At the same time we can not guard too carefully against the crowding out of that amount of practice obtainable from a well-equipped engineering laboratory and such tests of actual machinery as may be accessible. The highest justification of the American plan of engineering schools is to be found in the prominent part taken by comparatively recent graduates in the most difficult undertakings of engineering practice.

In the provision for science and engineering, indicated by the dedication of the Hale Scientific Building, the University of Colorado is following the best examples of American education. It has made a noble beginning in the cultivation of science, the augury we may be permitted to hope of a brilliant future. A wide world of discovery yet remains. The remark of an eminent physicist that the future discoveries of physical science are to be looked for in the sixth place of decimals is rendered rather ludicrous by the recent discovery of 'Argon,' a new constituent of the atmosphere, composing about two per cent. of its weight. If the air we breathe can furnish a new and al-

most unsuspected element, what other surprises may hide in equally common things? The twitching of a dead frog's leg a hundred years ago started a train of discoveries in electricity that have revolutionized the world. But Galvani was not the first anatomist who used the frog as illustrative material. Science knows no ultimate limits beyond which she may not go. The mountains of Colorado are not yet exhausted of their precious metals, nor has nature yet thrown up her hands as a signal that she no longer resists the uncovering of all her treasure.

I bear to you the congratulations of the Mother of State Universities, and the wish that this institution may be an intellectual light attracting the youths of Colorado, and a glory to this great Commonwealth.

HENRY S. CARHART.
UNIVERSITY OF MICHIGAN.

THE GROWTH OF FIRST-BORN CHILDREN.

DURING the year 1892 I made arrangements for a series of measurements of school children, one of the objects of which was the determination of any existing difference between the growth of first-born and later-born children. The measurements were taken in Toronto, under the direction of Dr. A. F. Chamberlain, and in Oakland, Cal., through the kindness of Professor Earl Barnes. The following table contains the results of the observations taken in Oakland.

The columns named 'Differences' gives the amount to be added to the average stature and weight in order to obtain the statures and weights of first-born and later-born children. The figures printed in parenthesis designate the numbers of individuals measured.

STATURES OF BOYS IN MILLIMETERS.

Ages. Years.	Average Stature.	Differences Between Average Stature and Stature of: First Born Children.	Second Born Children.	Third Born Children.	Fourth Born Children.	Later Born Children.
6.5	1137 (145)	+ 7 (30)	+ 7 (39)	—13 (25)	— 2 (16)	— 5 (33)
7.5	1180 (197)	+11 (49)	— 4 (42)	+13 (31)	± 0 (24)	—10 (46)
8.5	1249 (234)	— 3 (57)	— 7 (54)	— 1 (32)	—18 (25)	—21 (61)
9.5	1283 (220)	+ 2 (57)	— 2 (47)	+ 5 (38)	+ 5 (23)	+ 1 (46)
10.5	1334 (243)	± 0 (66)	+33 (49)	—18 (41)	—15 (35)	— 8 (47)
11.5	1379 (208)	— 1 (58)	+ 1 (39)	+16 (32)	—13 (27)	— 1 (45)
12.5	1426 (230)	+20 (66)	— 1 (47)	— 4 (38)	— 5 (36)	—19 (41)
13.5	1482 (184)	+16 (54)	+10 (43)	+16 (28)	—31 (26)	—25 (30)
14.5	1556 (163)	+11 (46)	—19 (40)	+ 4 (27)	± 0 (25)	+ 8 (24)
15.5	1632 (118)	+ 6 (35)	+ 8 (29)	—18 (22)	—14 (15)	+ 4 (17)
16.5	1668 (116)	—19 (29)	+17 (30)	+21 (18)	—20 (13)	± 0 (25)
Average Differences.		+4.5	+4.0	+1.9	—7.9	—6.9

STATURES OF GIRLS IN MILLIMETERS.

Ages. Years.	Average Stature.	Difference Between Average Stature and Stature of: First Born Children.	Second Born Children.	Third Born Children.	Fourth Born Children.	Later Born Children.
6.5	1125 (113)	+11 (32)	± 0 (28)	— 9 (15)	—16 (10)	— 1 (28)
7.5	1175 (199)	+ 8 (49)	— 1 (40)	+ 3 (44)	— 4 (24)	—11 (42)
8.5	1226 (221)	+14 (52)	—11 (46)	— 9 (43)	+13 (19)	— 4 (61)
9.5	1277 (252)	— 4 (65)	— 3 (57)	+14 (47)	—17 (21)	+ 5 (50)
10.5	1335 (224)	+ 7 (59)	— 2 (46)	+15 (28)	— 6 (26)	—11 (59)
11.5	1389 (226)	+12 (52)	+10 (41)	— 3 (32)	+ 3 (34)	—14 (61)
12.5	1450 (283)	+ 3 (65)	+14 (56)	— 1 (55)	+ 7 (40)	+ 8 (67)
13.5	1516 (222)	— 3 (62)	+ 9 (48)	—19 (38)	+ 6 (29)	+ 9 (45)
14.5	1566 (241)	+ 9 (61)	± 0 (68)	— 8 (38)	—17 (23)	— 1 (49)
15.5	1577 (170)	— 2 (42)	+11 (36)	— 6 (32)	— 1 (19)	— 5 (41)
16.5	1597 (127)	+15 (30)	—38 (28)	— 3 (23)	— 1 (14)	—18 (32)
17.5	1597 (99)	+10 (30)	—21 (19)	— 8 (19)	± 0 (15)	+14 (16)
18 & older	1602 (82)	+12 (27)	— 5 (20)	—25 (10)	—10 (9)	— 1 (16)
Average Differences.		+7.1	—2.8	—4.5	—3.3	—2.3